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BRASSICA CROSSES.

By

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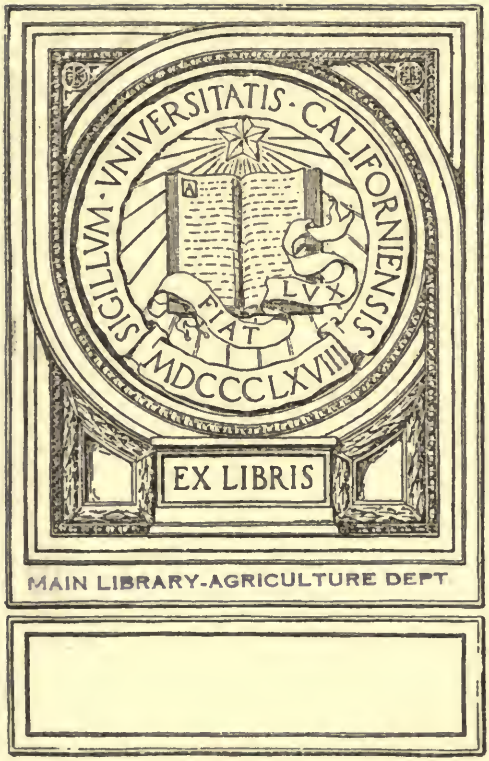

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EXPERIMENTS IN CROSSING A WILD PEA FROM PALESTINE WITH COMMERCIAL PEAS, WITH THE OBJECT OF TRACING ANY SPECIFIC IDENTITY BETWEEN THIS WILD PEA AND PEAS OF COMMERCE.

BY ARTHUR W. SUTTON, F.L.S., V.M.H.

When I was travelling in Palestine in the spring of 1904 I noticed growing wild amongst the vines, a small-podded Pea which appeared to differ from any I had seen before. The pods on the plant were already ripening and I could not, therefore, see the colour of the blooms, but in the absence of any purple colour in the axils (perhaps due to the advanced stage of growth) I hoped that the plant might prove to be a white-flowering type, and, as such, an original form of *Pisum sativum*, and thus also a possible parent of the garden Peas of the present day.

It is generally agreed that all commercial Peas belong to one of two species, either *Pisum sativum* or *Pisum arvense*, although some authorities consider *Pisum arvense* to be a sub-species of *Pisum sativum* or *vice versa*. *Pisum sativum* includes all those varieties of Peas grown by horticulturists, the seeds of which are used for the table in a green state as " *petits pois* " (*Pois à écosser*). These culinary Peas have white flowers, with green, yellow or white seeds, either wrinkled or round in form. On the other hand, all the varieties of field Peas (*Pois gris* or *Pois à fourrage*), the produce of which is harvested in a dry state as corn, may be said to belong to the species *Pisum arvense*, and in every case the varieties of this type have coloured flowers (generally bicoloured) and distinct coloured markings in the axils, whilst the seeds are invariably grey or brown and generally mottled. The only exception to this general rule is that certain Peas belonging to the species *Pisum arvense* are cultivated in gardens for culinary use, although these varieties are not grown to produce " green peas "—*i.e.*, " *petits pois*," but to supply fleshy pods which are sent to table whole. This class of Peas is known under the name of " *Pois mange-tout* " or " *Pois sans parchemin* " ; the pods are of very delicate flavour and it is for that reason they are grown, and not for the sake of the seeds which are always very immature when the pods are ready for gathering.

It is worthy of remark that the seeds of Peas belonging to the species *Pisum arvense*, when eaten raw in a young and green state, leave a bitter taste in the mouth ; whereas the seeds of every variety of *Pisum sativum* eaten under similar conditions are relatively sweet to the taste.

The outstanding features by which so-called varieties of *Pisum arvense* may be readily distinguished from those of the so-called *Pisum sativum* are that the former invariably have coloured flowers and colour in the axils, while the latter have white flowers and there is an entire absence of colour in the axils.

It may be well to mention at this stage that the wild Pea from Palestine proved by experiments to bear coloured flowers, *but without any colour in the axils*, thus differing from the commercial types of both *Pisum arvense* and *Pisum sativum*.

As seen growing in Palestine, the height of the plant was perhaps 20 inches, or a little less. The growth was by no means robust, and the pods, which were produced singly and in pairs, were very small, slightly curved and obtuse. The most interesting feature, however, was that the leaflets, which were also very small, were deeply serrated, a characteristic not found, so far as I am aware, in any other form either of *Pisum arvense* or *Pisum sativum*.

After bringing the plant home I removed the seeds from the pods and was surprised to find that, instead of being white or green, as I had hoped, the seed-coats varied from olive-green, heavily mottled with brown, to a dark green colour. The cotyledons were yellow; the seeds were nearly round, though slightly flattened, and very small and hard.

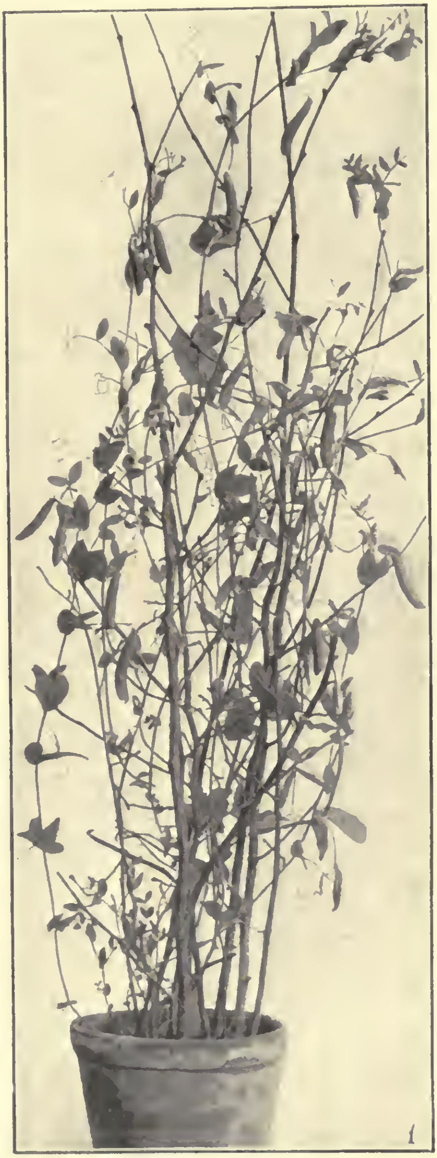

Fig. 1.—A plant of the Palestine Pea in full growth.

I sowed some of these seeds in my greenhouse during the summer of 1904 and allowed the plants to mature under the glass. Owing to the very hard nature of the seed-coat they were a long time germinating, but eventually the young plants flowered and ripened seed. In character, the plant was much as I had seen it in Palestine, but having been grown under glass, the stems were so very slender as to require support. When the flowers opened I found they were *self-coloured, of a shade much resembling magenta, and quite different from the blooms of any Peas I had previously grown.* Moreover, the pods contained a white woolly substance, somewhat similar to that found in the pods of *Fèves* (Broad Beans). As I was anxious to obtain a good supply of seed I did little in the way of crossing during 1904, but in subsequent years various crosses were made, particulars of which are given farther on.

N.B.—The Pea most nearly resembling this wild type from Palestine in general habit of growth appears to be one which I obtained a few years ago from Kew under the name of *Pisum quadratum*, which, like the former, has no colour in the axils. *Pisum quadratum*, however, is a little stronger in growth, the blooms are bicoloured instead of self-coloured, and the edges of the leaflets are practically entire. The seeds, which are very small, also differ from those of the Palestine Pea in being still rounder and not so dark in colour.

Tschermak had a Pea from Tadin of Svalof which had coloured flowers, but without colour in the axils. (*Zts. f. d. landw. Versuchswesen in Oesterr.*, 1902, p. 24). This is probably identical with a Pea I had from Svalof under the name of "Soloart," which grew to a height of 6 to 7 feet and much resembled the "Dun" field Pea, except that it had no colour in the axils. It is, however, perfectly distinct from the *Pisum quadratum* and the Palestine Pea. These three Peas (the Palestine, *Pisum quadratum* from Kew, and the Soloart) are the only instances known to me of Peas having coloured flowers but without colour in the axils.

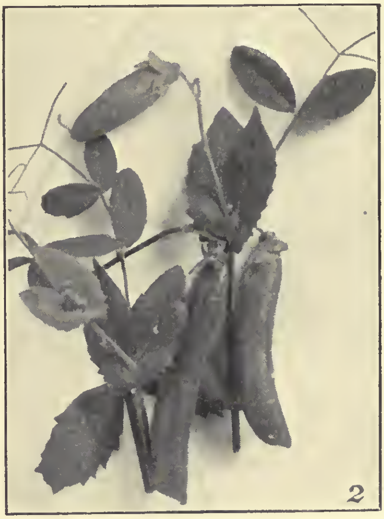

Fig. 2.—Pods and Foliage of Palestine Pea, to show serration of leaflets and small size of pods.

In 1905 and during successive years the Palestine Pea was grown in the Reading Experimental Grounds, and each year, as opportunity permitted, crosses were made between it and various forms of white-flowering culinary Peas (*Pisum sativum*) and between various forms of coloured-flowering Peas (*Pisum arvense*).

The method of culture adopted both for the pure strain of Palestine Pea and for the the hybrids was to sow the seeds in pots in gentle heat and afterwards to transplant to the open ground.

Altogether 40 crosses are here recorded, 24 being with white-flowering culinary types (forms of *Pisum sativum*) and 16 with coloured-flowering types (forms of *Pisum arvense*). In some of the crosses the Palestine Pea was used as the pollen parent and in others as the seed-bearing parent. Of these 40 crosses it was only found possible to continue the progeny of four to F3 (or farther), two of these being hybrids with the white-flowering types and two with the coloured-flowering types, and of these four hybrids only three are being grown during the year of writing (1911).

The fourth fertile cross (with a white-flowering type) was grown on to F4 and then by accident lost. It is described under "Crosses with degenerate plants produced by large-podded English Garden Peas."

A FEW OBSERVATIONS CONCERNING THE HYBRIDS.

*Seeds F*1.

When the Palestine Pea was used as the pollen parent the resulting seeds of the crosses were generally smaller in size than is usual in the seeds of the seed-bearing parent, and frequently the cotyledons were so badly developed as to make the seed-coat appear almost empty. In the reverse case, when the Palestine Pea was used as the seed-bearing parent, the resulting seeds of the crosses were like those of the Palestine Pea, but sometimes of a larger size.

Plants.

In F1 the hybrid plants were generally taller than those of the Palestine Pea, but when a very tall Pea (nearly 6½ feet in height) was used in the cross they did not reach the height of this taller parent. This fact may perhaps be explained by the weakness of the hybrids, which would probably have grown more freely and attained a greater height had they been raised entirely under glass.

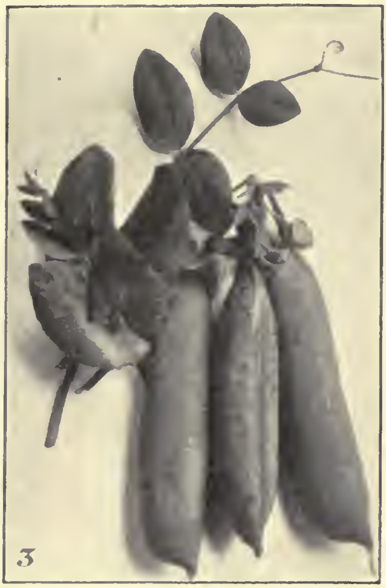

Fig. 3—Pods and foliage of an ordinary commercial small-podded variety of culinary Pea, for comparison with Fig. 2.

Coloured flowers were dominant over white flowers.

The serration of the leaves in a modified form was generally observed in all plants in F1; in some plants it was absent in F2. No plants resembling the parental Palestine Pea in form but with white blooms were noticed; if any were produced they probably died off prematurely.

The pods of the hybrids were usually very small, sometimes smaller than those of the Palestine Pea itself; they were badly developed, in most cases "puffy" with a woolly substance inside (as in *Fèves*), and were practically sterile. Those which were fertile were only partially so, although this feature of sterility seems to a certain extent to have been overcome in the cases of those hybrids still under culture in F4.

Generally some segregation occurred in F2, but as many of the plants were by no means well developed and consequently died off, and the experiments were undertaken with a view to ascertaining (if possible) the relationship of this Wild Palestine Pea to the cultivated types, rather than to test Mendelian laws, these results give us no profitable return.

It cannot be claimed as a result of my experiments that the Palestine Pea is certainly the forerunner of present-day garden Peas, for whilst on the one hand the fact that some of the hybrids are fertile and have been grown on to F4 might not preclude such a possibility, yet, on the other hand, the colour of the flowers, the serrated leaflets, the woolly nature of the interior of the pod, the type of seed, and the sterility of most of the hybrids would perhaps point to its not being so.

The failure to set seed in some cases may possibly be due to the difficulty of mating the strong-stemmed and strong-foliaged cultivated Pea with the slender and somewhat delicate Palestine Pea, which is, it should be remembered, an introduction from a warmer climate, and may not grow so vigorously in England as elsewhere.

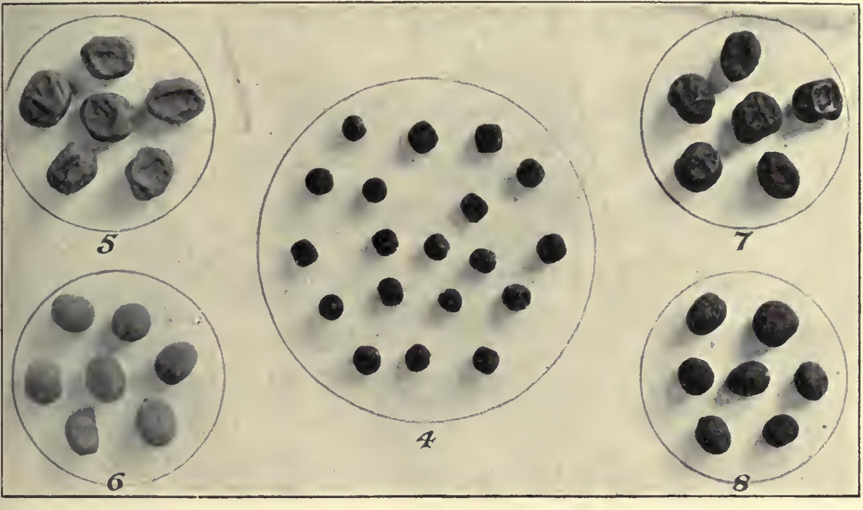

Fig. 4.—Seeds of the Palestine Pea. Figs. 5 and 6.—Wrinkled and Round Seeds of commercial varieties of white-flowering culinary Peas (*Pisum sativum*) for comparison. Figs. 7 and 8.—Wrinkled and Round Seeds of commercial varieties of coloured-flowering Peas (*Pisum arvense*) for comparison. The illustration shows the Seeds about half natural size.

Generally speaking, the hybrid plants grown this year (1911) are all stronger and more vigorous in habit than the parental Palestine form, although some have much of the same slender nature; the serration of the leaflets is seen in some; those which have coloured blooms are bicoloured (instead of self-coloured as is the Palestine Pea).

SUMMARY OF THE 40 CROSSES.

Crosses with round-seeded forms of the white-flowering culinary types (*Pisum sativum*).

5 crosses made, the varieties used being:

The Palestine Pea and
(*a*) *Pisum sativum* ex Kew.
(*b*) The "Bean-Pea" (Bohnenerbse).
(*c*) An Egyptian variety received from M. Vilmorin.

1 failed to germinate.
3 flowered but produced no seed.
1 only produced a few seeds in F2 and these failed to germinate.

Crosses with wrinkled-seeded forms of the white-flowering culinary types (*Pisum sativum*).

8 crosses made, the varieties used being:

The Palestine Pea and
(*a*) Sutton's Little Marvel.
(*b*) Duke of Albany.
(*c*) English Wonder.
(*d*) Sutton's Centenary.
(*e*) Quite Content.

1 died off immediately after germinating.
5 flowered but produced no seed.
2 only produced a few seeds in F2, but when sown, the resulting plants died off before reaching the flowering stage.

Crosses with umbellate or crown-flowering type: round-seeded, white-flowered. (*Pisum sativum umbellatum*).

6 crosses made, the varieties used being:

The Palestine Pea and
Pisum sativum umbellatum, or the so-called "Mummy" Pea.

2 failed to germinate.
1 died off immediately after germination.
1 flowered but produced no seed.
2 produced a few seeds in F2. Of these 1 failed to germinate, but the other proved fertile.

In F2 the plants did not show the umbellate character. Two of them were much like the parental Palestine Pea, having somewhat serrated foliage, but with colour in the axils; the other three plants were distinctly stronger in growth, with larger foliage and not much serration.

Only one type produced fertile seeds in F3. The resulting plants were partly of the umbellate character and partly not. Most of the blooms were bicoloured, but some were white. None of the plants were like the parental Palestine Pea, all being much stronger in growth, and the leaves were not serrated. From these plants four different types were selected and the produce grown in F4 (1911).

Of these, one selection which was in F3 a bicolour-flowered umbellate, gave in F4 some white-flowered umbellate forms, as well as plants with dark bicoloured- and rose and white bicoloured-flowers.

Another selection with white blooms and not of umbellate form has come true to type.

A third selection, with bicoloured flowers and not of umbellate form, is true to non-umbellate form and bicoloured blooms; whilst the fourth plant which had bicoloured flowers and was not umbellate, has now produced two plants of umbellate form.

All the plants in 1911 suffered from the continuous dry weather, but all were much stronger in growth than the parental Palestine form.

Crosses with degenerate plants produced by the large-podded English Garden Peas (white-flowered).

It is, of course, well known that the large-podded types of garden Peas often produce degenerate plants having a very wild appearance and bearing curved pods. With plants of this type crosses were made as follows :—

5 crosses made, the varieties used being :
The Palestine Pea and
(*a*) Duke of Albany.
(*b*) Ne Plus Ultra.

1 failed to germinate.
2 flowered but produced no seed.
The remaining two gave results as follows :

Hybrid 4. The F1 plants gave a few seeds only, from which two plants were produced in F2—one bicolour-flowered and one white-flowered. The white-flowered plant was completely sterile, while the bicolour-flowered type produced four seeds from which two plants were raised in F3, and these proved to be completely sterile.

Hybrid 5. The F1 plants gave a few seeds only, from which, however, only one plant was raised in F2. This plant was 3 feet high, bicolour-bloomed, with small stumpy pods, and was much like a stronger type of the Palestine Pea. Two seeds only were produced, one of which failed to germinate, while the other gave a plant in F3. This plant was 5 to 6 feet in height, had bicoloured flowers, non-serrate leaflets, and fair-sized pale stumpy pods. Colour showed in the axils. It proved to be quite fertile and was grown to F4. The F4 plants were generally very similar in appearance—4 to 5 feet in height ; all had bicoloured flowers, no whites appearing ; scarcely any trace of serration was noticeable ; all had pale stumpy pods. After having been grown to F4 this cross was, as before mentioned, by accident lost.

Crosses with bicolour-flowering types (Pisum arvense).

Crosses with dark bicolour-flowered : round-seeded, grey or mottled (Pisum arvense).

11 crosses made, the varieties used being :
The Palestine Pea and
(*a*) Purple-podded Pea.
(*b*) *Pisum Jomardi* (? *arvense* type).
(*c*) A type of the "Maple" field Pea.
(*d*) *Pisum quadratum* ex Kew.
(*e*) An Egyptian Pea received from M. Vilmorin.

4 failed to germinate.
3 germinated but died off.
1 flowered but produced no seed.
2 gave a few seeds only.
1 proved to be quite fertile.
Of the last three mentioned which gave seeds :
1 flowered but produced no seed.
2 were quite fertile.

These in F2 gave no plants like the parental Palestine form. All were stronger in growth ; the colour of the blooms varied ; the foliage was somewhat serrated and there was colour in the axils.

In F3 the plants were generally like a stronger Palestine Pea, with colour in axils and somewhat serrated leaflets.

In F4 (growing in 1911) the plants generally appear to be intermediate between the two parents in form. Blooms are bicoloured. Some show serration, others do not, and the majority appear to have colour in the axils.

Cross with pale bicolour-flowered (rose and white) type : grey- or mottled-seeded (Pisum arvense).

1 cross made, the varieties used being : The Palestine Pea and Dutch Capucin Pea with Lathyrus blossom.	This failed to germinate.

Crosses with pale bicolour-flowered (rose and white) umbellate type : grey round-seeded (Pisum arvense).

3 crosses made, the varieties used being : The Palestine Pea and the so-called " Mummy " Pea.	2 failed to germinate. 1 died off immediately after germination.

Cross with dark bicolour-flowered, " sugar " type (Pois Mangetout *or* Pois sans parchemin) : *constricted pods, grey round-seeded.*

1 cross made, the varieties used being : The Palestine Pea and *Pois sans parchemin à large cosse.*	Flowered, but produced no seed.

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